

### **REMARKS**

Applicants concurrently file a Petition and Fee for a One-Month Extension of Time.

Applicants concurrently file herewith an Excess Claim Fee Payment Letter for one (1) independent claim and seven (7) excess total claims.

Claims 1-26 and 28-40 are all of the claims presently pending in the application. Claims 1, 3-5, 7-8, 13-15, 19-21, 24-26 and 28-29 have been amended to more particularly define the invention. Claims 33-40 have been added to claim additional features of the invention and to provide more varied protection for the claimed invention. Claim 27 has been canceled without prejudice or disclaimer.

It is noted that the claim amendments are made only for more particularly pointing out the invention, and not for distinguishing the invention over the prior art, narrowing the claims or for any statutory requirements of patentability. Further, Applicants specifically state that no amendment to any claim herein should be construed as a disclaimer of any interest in or right to an equivalent of any element or feature of the amended claim.

Applicants gratefully acknowledge the Examiner's indication that claim 23 would be allowable if rewritten in independent form. However, Applicants respectfully submit that all of the claims are allowable.

Claims 1-6, 9-12, 18-22, 24-25, and 30 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Talwar et al. (U.S. Patent No. 6,380,044) (hereinafter "Talwar"). Claims 7-8 and 29 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Talwar. Claims 13-17 and 26-28 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Talwar et al. in view of Yu (U.S. Patent No. 6,235,599). Claims 30 and 32 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Talwar et al. in view of Sugawara et al. (U.S. Publication No. 2001/0003364) (hereinafter "Sugawara").

These rejections are respectfully traversed in the following discussion.

#### **I. THE CLAIMED INVENTION**

The claimed invention (e.g., as defined by claim 1) is directed to a method of forming a semiconductor device. The method includes implanting, on a substrate, a dopant to form a dopant extension region, implanting at least one species, on a substrate, to form a region

surrounding at least a portion of the dopant extension region, and annealing the substrate, wherein the at least one species retards a diffusion of the dopant during the annealing of the substrate.

Strained Si complementary metal oxide semiconductor devices having a strained Si channel on a relaxed  $\text{Si}_{1-x}\text{Ge}_x$  buffer layer offer better device performance over conventional Si CMOS because of the enhancement in both channel electron and hole mobilities, and have been demonstrated for devices as small as about 60nm. For devices smaller than 60nm, an extension junction depth of 30nm or below is need. This shallow junction requirement, however, is difficult to achieve for a dopant (e.g., arsenic) junction in N-type metal oxide semiconductor devices in strained Si/ $\text{Si}_{1-x}\text{Ge}_x$  substrates due to significant arsenic-enhanced diffusion (see Application at page 2, lines 8-11).

The claimed invention of exemplary claim 1, on the other hand, provides a method of forming a semiconductor device that includes implanting at least one species, on a substrate, to form a region surrounding at least a portion of the dopant extension region (e.g., see Application at page 17, lines 10-14). The at least one species implanted on the substrate creates vacancy sinks in the vicinity of the dopant extension region, which thereby retard the diffusion of arsenic (see Application at page 18, lines 1-4).

## II. THE PRIOR ART REFERENCES

### A. The Talwar Reference

The Examiner alleges that Talwar teaches the claimed invention of claims 1-6, 9-12, 18-22, 24, 25 and 30. Furthermore, the Examiner alleges that the claimed invention of claims 7, 8 and 29 would have been obvious in view of Talwar. Applicants submit, however, that there are elements of the claimed invention which are neither taught nor suggested by Talwar.

That is, Talwar does not teach or suggest “*implanting at least one species, on a substrate to form a region surrounding at least a portion of said dopant extension region*” as recited in claim 1 and similarly recited in claims 24 and 25.

As noted above, unlike conventional semiconductor devices forming methods, the claimed invention of exemplary claim 1 provides a method of forming a semiconductor device that includes implanting at least one species, on a substrate, to form a region surrounding at least a portion of the dopant extension region (e.g., see Application at page 17, lines 10-14). The at least one species implanted on the substrate creates vacancy sinks in the vicinity of the

dopant extension region, which thereby retard the diffusion of arsenic (see Application at page 18, lines 1-4).

The novel features of the claimed invention are not taught or suggested by Talwar. Indeed, the Examiner attempts to rely on Figures 1A-1G and columns 7 and 8 of Talwar to support her allegations. The Examiner, however, is clearly incorrect.

Nowhere, in these Figures or passages (nor anywhere else for that matter) does Talwar teach or suggest implanting at least one species, on a substrate, to form a region surrounding at least a portion of the dopant extension region. Indeed, the Examiner does not even allege that Talwar teaches or suggests this feature. In fact, the Examiner merely alleges that Talwar teaches implanting a dopant and at least one species on a semiconductor substrate.

Talwar merely teaches forming doped extensions by first amorphizing two regions on a substrate. The regions of the silicon substrate are amorphized by destroying the chemical bonds between silicon atoms in the silicon substrate through ion implantation. The amorphized regions are then doped with a dopant thereby forming doped extensions (Talwar at column 7 line 24 through column 8, line 10).

As shown in Figures 1A through 1E (the Figures relied upon by the Examiner), a doped region (60,62) is formed on each side of the substrate. Talwar does not teach, however, a region formed by implanting at least one species, that surrounds the doped region. As is exemplarily shown in Figures 4A through 4D, the claimed method includes implanting at least one species, on a substrate, to form a region (430) surrounding at least a portion of the dopant extension region (440).

The atom/ion species implanted on the substrate creates vacancy sinks in the vicinity of the arsenic dopant. The presence of the vacancy sinks created by the atom/ion species removes vacancies in the vicinity of the arsenic dopant, thereby slowing down the arsenic diffusion (see Application at page 18, lines 1-4). Talwar does not even mention providing a region to prevent the diffusion of the dopant. Talwar is merely directed to a process of fabricating a semiconductor metal-insulator-metal field effect transistor.

Therefore, Applicants submit that there are elements of the claimed invention that are not taught or suggest by Talwar. Therefore, the Examiner is respectfully requested to withdraw this rejection.

**B. The Yu Reference**

The Examiner alleges that Yu would have been combined with Talwar to form the claimed invention of claims 13-17 and 26-28. Applicants submit, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Applicants submit that these references would not have been combined as alleged by the Examiner. Indeed, these references are directed to different problems and solutions. Specifically, Talwar is directed to a process of fabricating a semiconductor metal-insulator-metal field effect transistor, whereas Yu is directed to a shallow doped junction that is part of an integrated circuit device within a semiconductor substrate. Therefore, these references are completely unrelated, and no person of ordinary skill in the art would have considered combining these disparate references, absent impermissible hindsight.

Furthermore, the Examiner's motivation to modify Talwar ("to form a low resistant contact over the source drain region") does not appear to be a problem in Talwar that would require a solution. Talwar already includes a protective layer (106) that is formed over the source and the drain. Thus, as pointed out in MPEP 2143.01, the Examiner's motivation is "improper". That is, "the mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination" (emphasis included in MPEP).

Moreover, neither Talwar nor Yu, nor any combination thereof, teaches or suggests *"implanting at least one species, on a substrate to form a region surrounding at least a portion of said dopant extension region"* as recited in claim 1 and similarly recited in claims 24 and 25.

The novel features of the claimed invention are not taught or suggested by Yu. Indeed, the Examiner merely attempts to rely on Yu as allegedly suggesting forming a metal silicide contact over the source and drain region. The Examiner attempts to rely on Figure 1 of Yu to support her allegations. The Examiner, however, is clearly incorrect.

Nowhere, in this Figure (nor anywhere else for that matter) does Yu teach or suggest implanting at least one species, on a substrate, to form a region surrounding at least a portion of the dopant extension region. Indeed, the Examiner does not even allege that Yu teaches or suggests this feature.

Therefore, Applicants respectfully submit that these references would not have been

combined, and that, even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

### C. The Sugawara Reference

The Examiner alleges that Sugawara would have been combined with Talwar to form the claimed invention of claims 30 and 32. Applicants submit, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Applicants submit that these references would not have been combined as alleged by the Examiner. Indeed, these references are directed to different problems and solutions. Specifically, Talwar is directed to a process of fabricating a semiconductor metal-insulator-metal field effect transistor, whereas Sugawara is directed to a semiconductor device that is capable of increasing the operation speed and reducing the power consumption by providing an nMOS in which the mobility of electrons is increased by a strain effect and a pMOS in which the mobility of positive holes is increased by the strain effect on a common substrate. Therefore, these references are completely unrelated, and no person of ordinary skill in the art would have considered combining these disparate references, absent impermissible hindsight.

Furthermore, the Examiner's motivation to modify Talwar ("to increase mobility of ions so that the speed and the device performance can be increased") does not appear to be a problem in Talwar that would require a solution. Thus, as pointed out in MPEP 2143.01, the Examiner's motivation is "improper". That is, "the mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination" (emphasis included in MPEP).

Moreover, neither Talwar nor Sugawara, nor any combination thereof, teaches or suggests "*implanting at least one species, on a substrate to form a region surrounding at least a portion of said dopant extension region*" as recited in claim 1 and similarly recited in claims 24 and 25.

The novel features of the claimed invention are not taught or suggested by Sugawara. Indeed, the Examiner merely attempts to rely on Sugawara as allegedly suggesting strained and relaxed SiGe substrate that include one of compressive and tensile strain. The Examiner attempts to rely on paragraph [0013] of Sugawara to support her allegations. The Examiner,

however, is clearly incorrect.

Nowhere, in this passage (nor anywhere else for that matter) does Sugawara teach or suggest implanting at least one species, on a substrate, to form a region surrounding at least a portion of the dopant extension region. Indeed, the Examiner does not even allege that Sugawara teaches or suggests this feature.

Therefore, Applicants respectfully submit that these references would not have been combined, and that, even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

### **III. NEW CLAIMS**

New claims 33-40 have been added to provide more varied protection for the claimed invention and to claim additional features of the invention. These claims are independently patentable because of the novel features recited therein.

Applicants respectfully submit that new claims 33-40 are patentable over any combination of the applied references at least for analogous reasons to those set forth above with respect to claims 1-26 and 28-32.

### **IV. FORMAL MATTERS AND CONCLUSION**

In response to Examiner's objections, the claims, have been amended in a manner believed fully responsive to all points raised by the Examiner.

In response to Examiner's objections to the Drawings, Applicants concurrently file herewith replacement sheets for Figures 1-7G. These replacement sheets include Figure 6E which is believed to have been submitted with from the originally filed Application, as indicated by the USPTO date-stamped filing receipt attached hereto. In any event, Figure 6E is attached hereto. Applicants respectfully submit that no new matter is included in Figure 6E. Specifically, the subject matter of Figure 6E is fully disclosed at page 21 line 17 through page 23, line 15 of the Application.

In response to the Examiner's objection to the Specification, Applicants respectfully submit that the subject matter of claim 23 has proper antecedent basis in the Specification. Specifically, the Specification recites "It is noted that, after step 510 (e.g., performing the atom/ion species implantation) and before step 520 of forming the As extension implant, an

anneal could be optionally performed immediately thereafter to remove the damage created by the species implantation" (see Application at page 20, line 21 through page 21, line 1). The Examiner is respectfully requested to withdraw this objection.

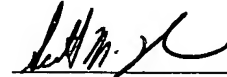
In view of the foregoing, Applicants submit that claims 1-26 and 28-40, all of the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Assignee's Deposit Account No. 50-0510.

Respectfully Submitted,

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